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EDITORIAL

TRANSPORT OF ANIMALS

TRANSPORT is the hub around which the modern world revolves and it has become such an essential factor in our well-being that if it were impeded or called to a halt national and international economy would be cast into grave peril and might even fall into ruin.

Questions relating to transport can excite a constant and lively flow of words and argument whenever two or three people are gathered together. It is a sure elixir to sparkle the mind and revive the tongue when speech has become languorous and dull. Mention of the state of the roads or the railways, particularly those used by the commuters in their daily perambulations to and from work, and the air will reverberate with stories of discomfort and exasperating experiences. There will be no lack of opinion as to the cause of this unwarranted addition to the toll of human suffering and the appropriate and simple remedy thereof. But if we should wish to turn the meeting into one of real righteous indignation one should draw the audience's attention to the tribulations of the animals which are carried hither and thither. It is a strange fact that British people count human discomfort and suffering as naught when compared with that of animals. This sentimental outlook is a traditional and cherished attribute of our race. Most of the iniquities and discomforts of human transport are borne voluntarily and would respond to simple remedy. If one chose to live within walking distance of the office instead of ten or more miles away then the hundreds of crowded trains

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and buses which, crammed to bursting point, pass one another on the rails and roads could be reduced to a very small trickle, their courses would be clear and fast and a ticket would ensure a comfortable seat. In recent times a considerable export trade has developed in live cattle destined to continental slaughterhouses. For economic reasons this trade is very welcome for it has provided another outlet for home-reared meat which was tending towards a surplus and it has solved temporarily the repercussions which accompany such a state of affairs. The cattle are transported by road, rail, sea and air and considerable anxiety has been felt and much animadversion expressed anent the conditions to which the animals are subjected on the journey to their doom. The fact that they were going on a journey from which there is no return has served to amplify the sorrow and anxiety felt by those of kindly heart. We should be proud that the majority of our people are of this sentiment and that a suggestion or indication that animals are subjected to any form of cruel treatment gives rise to an immediate and vociferous demand for remedy by parliamentary or legal means. The present traffic in the export of live cattle to the continent has elicited the above response in no uncertain manner, and a committee, under the chairmanship of Lord Balfour of Burleigh, was appointed to investigate the matter. The report of the committee was published on April 30, and if the recommendations are implemented there would be an end to any suspicion of cruelty. Most of the complaints which had been voiced were concerned with incidents occurring during the period of transport on the sea, on the road and railways, and in the air. Sometimes the animals may be many days on their journey, but the report implies that the hazards are not sufficient to warrant the prohibition of the trade, and the alternative, to export carcases, is feasible to a limited extent only. This trade in live cattle for slaughter on the continent began through a contract for the supply of meat to the American forces. It would appear that the American authorities considered that the conditions appertaining in our slaughterhouses fall short of the standards demanded by the American Army Veterinary Corps, the body responsible for the wholesomeness of the food for their army. Apparently continental conditions comply with their stringent regulations. This may come as a shock to many people who are not conversant with conditions in this country. We may not have a multiplicity of slaughterhouses resembling marble palaces in which the legal and hygienic control is conducted with a rigid military precision by a corps of civil servants in uniform, but good wholesome meat, which will match in quality that produced in any other part of the world, can be produced and is produced in this country. Our slaughterhouses and meat-inspection service are not ideal, much could be done to improve the service, but in spite of obvious shortcomings, tapeworms are not as common in British human gut as they are in the continental counterpart.

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GENERAL ARTICLES

THE EFFECT OF REPEATED SHORT EXPOSURES TO HEAT ON THE VOLUME AND HYDRATION OF THE BLOOD OF THE CALF

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Introduction

MAN responds to high environmental temperatures by dilatation of skin vessels and by sweating. Both these responses entail changes in body fluids which may be reflected in the blood. Peripheral vasodilatation demands an increase in circulating blood volume (Bass and Henschel, 1956), while extensive sweating produces dehydration which tends to reduce the circulating plasma volume and to cause hæmoconcentration (Adolph, 1947).

In cattle exposed to heat the extent to which peripheral vasodilatation occurs is not established; sweating is not profuse as in man (Kibler and Brody, 1950; Findlay, 1954), but there is increased respiratory activity which causes moisture to be lost from the body at an increased rate (Kibler and Brody, 1950).

Few experiments on the influence of heat on the volume and concentration of the blood of cattle have been reported in the literature. Reynolds (1953) stated that "in eleven plasma volume determinations on one heifer during a four-month period from August through November, in spite of a probable over-all air temperature decrease from 32° to 10° C. (90° to 50° F.), there was no trend in the plasma volume." Brody (1949) found that the plasma protein concentration of cows did not alter significantly within the range of environmental temperature 10° to 38° C. (50° to 100° F.), from which he concluded that the water balance between blood and tissue had remained constant. Dale, Brody and Burge (1956) determined blood and serum volumes in cows kept for periods of about three weeks under various diurnal temperature rhythms. They found that blood and serum volumes were increased by 20 to 30 per cent during high temperature rhythms which included air temperatures up to 43° C. (110° F.), and demonstrated differences between dry and lactating animals.

The present work was undertaken to find the effect of repeated short exposures to heat on the volume and hydration of the blood of calves.

Materials and Methods

Animals.

Six 4-month-old Ayrshire bull calves were used, three as experimental animals (E_1, E_2, E_3) and three as controls (C_1, C_2, C_3). They were held in a byre, the air temperature of which was recorded daily. Feeding consisted of 3 lb. concentrates per head per day with hay and water *ad lib.* Six similar calves (A, B, C, D, E, F) were used for a number of supplementary experiments on certain aspects of the problem.

Procedure.

The experiments were conducted on pairs of animals; at any one time two calves were under investigation: E_1 and C_1, E_2 and C_2, E_3 and C_3.

The experimental conditions were designed to allow the occurrence in the animals of: (1) short-term reactions to acute heat stress, (2) acclimatisation to heat, and (3) body cooling solely by evaporation. The following procedure was used to meet these requirements.

Each experimental calf was kept for a two-week control period at normal air temperature. It was then exposed in a climatic room throughout a three-week experimental period for up to five hours each day to an atmosphere of 45.0° C. (113.0° F.) dry bulb and of 27.6° C. (81.7° F) wet bulb temperature, corresponding to an absolute humidity of 17 mg./l. or a relative humidity of 26 per cent. If the rectal temperature of the calf reached 42.0° C. (107.6° F.) the calf was withdrawn from the climatic room before the five-hour exposure was completed. This occurred 11 times in 63 exposures. During heat exposure, readings were taken once every five minutes of the dry bulb and wet bulb temperature of the room, of rectal temperature and respiration rate. Every ten minutes the heart rate was measured.

Once every five days, at the end of heat exposure, a blood sample was drawn aseptically from the external jugular vein into a tube containing a constant amount of heparin dried to its wall. A known volume of the dye T-1824 (Evans Blue) in saline was then injected into the same vessel over a period of 60 seconds, followed by a small quantity of rinsing saline. Over the next hour six blood samples were collected at intervals of 10 minutes. To reduce the risk of exciting the calf and thereby causing hæmatological changes, sampling and injection were carried out by way of an indwelling trocar cannula (Bianca, 1955). After this the calf returned to the byre where it was fed and watered.

The experimental period was followed by a two-week recovery period at normal air temperature. In the control and recovery period blood sampling was carried out in the byre.

The control calves were kept throughout the three periods at normal air temperature in the byre where blood sampling was done. In the morning of each experimental day the experimental calf and its control partner were weighed.

Methods.

Blood volume, plasma volume, cell volume and cell percentage (volume of cells as a percentage of the volume of whole blood) were estimated by a dye dilution method described by Bianca (1950).

Plasma solids concentration was determinated gravimetrically on 1 ml. of plasma which was oven-dried for four hours at 105° C. (221° F.). The results were expressed as percentages on a weight per weight basis.

Total plasma solids and total plasma water were computed from the plasma solids concentration and the plasma volume.

Plasma protein concentration was estimated from the specific gravities of the blood and plasma, determined by the copper sulphate method described by

Hawk, Oser and Summerson (1947). This method in a duplicated sample gave figures within ±1 per cent of those determined by the micro-Kjeldahl method.

Rectal temperature was determined thermoelectrically (Beakley and Findlay, 1955*a*) and respiration rate by a stethograph (Beakley and Findlay, 1955*b*). Heart rate was measured with a stethoscope.

Results

Normal Values

During the control period all six animals were living continuously in a temperate climate which had an average dry bulb temperature of 11.6° C. (52.9° F.) with a standard deviation of ±4.95° C. (8.91° F.). Since Kibler and Brody (1949) found that for Holstein and Friesian cows there was a zone of thermoneutrality between about 4° and 16° C. (40° and 60° F.) air temperature, the results for the control period which are given in Table 1 may be considered normal values.

TABLE 1. Haematological measurements on six calves at normal air temperature

(Each figure represents the mean ± the standard error of the mean of 18 measurements, 3 for each calf)

Quantity	Mean	±	S.E.
Blood volume	65.4	±	1.12 ml/kg
Plasma volume	47.5	±	0.78 ml/kg
Cell volume	17.9	±	0.61 ml/kg
Cell percentage	27.4	±	0.66%
Plasma solids concentration	7.67	±	0.084%
Total plasma solids	3.64	±	0.080 g/kg
Plasma specific gravity*	1.0246	±	0.00042
Plasma protein concentration*	6.51	±	0.162 g/100 ml.

* Mean of a total of six measurements only (calves K_3 and C_3)

The only previously published measurements of blood volume in calves appear to be those of Hansard, Butler, Comar and Hobbs (1953). These workers obtained values of 120, 85, 62 and 58 ml./kg. body weight for animals aged 2 to 6 days, 3 weeks, 2 to 3 months and 6 to 8 months. The value of 65.4 ml./kg. determined in the present work on 3-month-old calves is in fair agreement with the above value of 62 ml./kg. Cows seem to have lower blood volumes than calves. Bianca (1950), Reynolds (1953) and Hansard *et al.* (1953) reported values of 57.2, 57.4 and 57.0 ml./kg. for cows.

The blood of the calves had a comparatively high plasma volume (47.5 ml./kg.) and a comparatively low cell volume (17.9 ml./kg.), which is also

expressed in a low cell percentage (27.4 per cent). Wehmeyer (1954) found that in red Danish cattle a fall in the cell percentage from 35 to 28 per cent occurred during the first half year of life. Other workers, Duckworth and Rattray (1948), Hansard *et al.* (1953), Greatorex (1954) and Holman (1956) have reported higher figures for the cell percentage of calf blood. Comparisons are, however, difficult because of lack of uniformity in the methods used.

The figure of 6.51 g./100 ml. for plasma protein concentration is much the same as that given by Wehmeyer (1954) for 3-month-old Red Danish calves, namely 5.78 g./100 ml. serum protein + 0.6 g./100 ml. fibrinogen, giving a plasma protein concentration of 6.38 g./100 ml. Consistently higher figures for plasma protein concentration have been reported for the cow by Brody (1949) and Albritton (1952). In accord with this difference the plasma solids concentration and the plasma specific gravity are also higher in cows (Albritton, 1952; Dukes, 1955) than in calves.

Effects of Heat

(1) *Body weight.*

Table 2 shows that the body weights of the experimental and control animals were similar throughout the three periods, indicating that the heat stress imposed on the experimental animals had no adverse effect on their growth rates. This

TABLE 2

Body weight and hæmatological measurements averaged for the three experimental calves (E) and for the three control calves (C).

PERIOD	EXPERIMENT NO.	BODY WEIGHT		BLOOD VOLUME		PLASMA VOLUME		CELL VOLUME		CELL PERCENTAGE		PLASMA SOLIDS CONC.		TOTAL PLASMA SOLIDS		TOTAL PLASMA WATER	
		kg		ml/kg		ml/kg		ml/kg		%		%		g/kg		g/kg	
		E	C	E	C	E	C	E	C	E	C	E	C	E	C	E	C
CONTROL	1	89.4	89.0	66.3	70.2	47.4	49.6	18.9	20.6	28.2	29.2	7.76	7.71	3.63	3.82	43.8	45.8
	2	93.0	93.8	59.5	67.2	43.9	49.0	15.6	18.2	26.2	27.0	7.53	7.77	3.30	3.81	40.6	45.2
	3	96.3	96.8	61.9	67.1	45.8	49.1	16.1	18.0	26.0	26.7	7.51	7.85	3.44	3.85	42.4	45.2
	MEAN	92.9	93.2	62.6	68.1	45.7	49.2	16.9	18.9	26.8	27.6	7.57	7.78	3.45	3.83	42.2	45.4
EXPERIMENTAL	4	98.6	99.9	64.9	67.3	43.2	48.8	21.7	18.5	33.2	27.4	8.23	7.95	3.54	3.88	39.7	44.9
	5	102.4	103.4	66.6	69.4	48.5	49.8	18.1	19.6	27.1	28.2	7.77	7.77	3.77	3.87	44.7	45.9
	6	106.6	107.8	64.7	68.1	47.9	48.3	16.8	19.8	25.8	29.1	7.83	7.56	3.75	3.66	44.1	44.6
	7	109.8	112.3	64.1	66.4	46.8	48.0	17.3	18.4	27.0	27.7	7.83	7.62	3.66	3.66	43.1	44.3
	8	114.2	114.8	63.4	65.8	45.7	47.5	17.7	18.3	27.4	27.2	7.77	7.68	3.55	3.65	42.1	43.8
	MEAN	106.3	107.7	64.7	67.4	46.4	48.5	18.3	18.9	28.0	27.9	7.89	7.71	3.66	3.74	42.7	44.8
RECOVERY	9	117.7	118.6	65.5	65.9	47.1	47.0	18.4	18.9	28.0	28.7	7.72	7.76	3.63	3.65	43.5	43.3
	10	120.9	121.6	62.7	65.0	45.2	46.9	17.5	18.1	27.8	27.8	7.57	7.72	3.42	3.62	41.8	43.3
	11	123.6	125.5	61.9	61.3	44.6	44.3	17.3	17.0	27.8	27.8	7.55	7.78	3.37	3.44	41.2	40.9
	MEAN	120.7	121.9	63.3	64.1	45.6	46.1	17.7	18.0	27.9	28.1	7.61	7.75	3.47	3.57	42.1	42.5

finding was also useful with regard to the presentation of the results, since it enabled the various volumes to be expressed in terms of volumes per kilogram of body weight, thus making them all directly comparable with each other.

(2) *Blood volume, plasma volume and cell volume.*

No statistically significant changes from normal were observed over the whole range of the experimental period. Inspection of single experiments, how-

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ever, showed that there were definite trends in the behaviour of the experimental group. These trends are shown in Fig. 1, in which the mean values for each group for every experimental day are plotted as percentage deviations from their respective mean values in the control period.

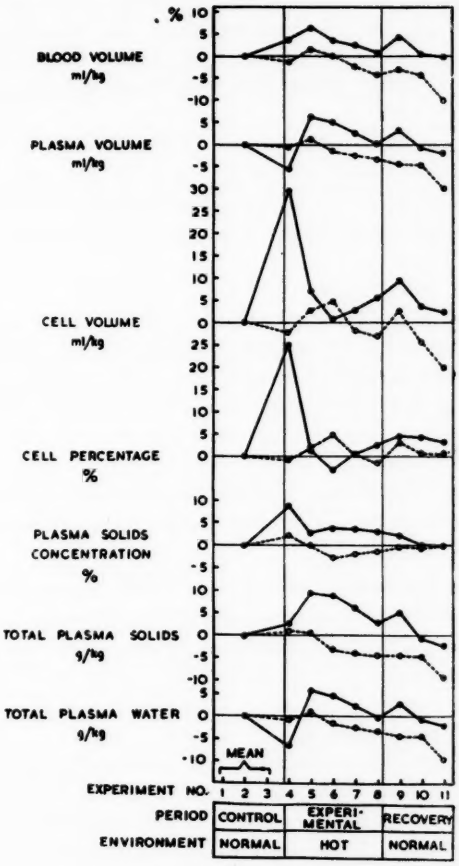

Fig. 1
Percentage changes in the hæmatological measurements, averaged for the three experimental calves (———) and for the three control calves (——).

It is apparent from Fig. 1 that at normal air temperature there was a general tendency for blood, plasma and cell volumes per unit of body weight to decrease with increasing age. This finding confirms that of Hansard *et al.* (1953). Superimposed on this effect of age there was a transient effect of heat. On the first day of exposure to heat the average plasma volume fell in the experimental group. Within the following five days it rose beyond the corresponding level of the

control group. The reverse trends occurred with the cell volume. It rose to a maximum on the first day of heat exposure and fell thereafter. As a result of this complementary behaviour the blood volume was not altered appreciably at the beginning of the experimental period.

During the rest of the experimental period the values returned to their pre-heat levels. After three weeks' heat treatment the relative figures for plasma volume, cell volume and blood volume were slightly higher in the experimental than in the control group. These differences were also maintained during the recovery period.

(3) *Cell percentage.*

The cell percentage of the venous blood followed the same general course as the cell volume, increasing at first exposure to heat and returning to normal.

(4) *Plasma solids concentration.*

As a measure of the state of hydration of the blood the concentration of solids was determined in the plasma rather than in the whole blood because water exchange in the body is effected predominantly through the plasma. Including the red blood cells in the measurement would have complicated the picture, since the erythrocytes have a much lower water content than the plasma and their volume in circulation may vary considerably, as stated above. Thus, if the water content of the whole blood were found to be changed, this might be due to an actual change in the amount of plasma water or to a change in the volume of circulating cells, or to both.

The first exposure to heat caused a rise in the concentration of the plasma solids (Fig. 1). This rise was less than that of the cell percentage. In subsequent exposures the plasma solids concentration did not return to normal throughout the experimental period.

(5) *Plasma protein concentration.*

Since the plasma solids consist mainly of protein, the above finding indicated that during heat exposure there was an increased concentration of plasma proteins. To confirm this point the plasma protein concentration was determined in experimental calf E_3 and control calf C_3. Table 3 shows that the concentrations of the proteins and of the solids of the plasma behaved similarly.

Further evidence of the simultaneous rise in cell percentage and plasma protein concentration occurring during first exposure to heat was obtained from four other calves. Table 4 shows that heat caused both to rise and, again, the increases were larger in the cell percentages than they were in the plasma protein concentrations.

Finally, one calf (E) was exposed on six consecutive days for a short period to an atmosphere of 40.0° C. (104.0° F.) dry bulb and 38.1° C. (100.6° F.) wet bulb temperature. Under this extreme thermal condition, which allows only a very limited heat loss from the animal by evaporation, similar hæmato-

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TABLE 3

Plasma protein concentration (g/100 ml.) and plasma solids concentration (%) in the third pair of calves.

Period	Experiment No.	Experimental calf 3			Control calf 3		
		Protein	Solids	Protein / Solids	Protein	Solids	Protein / Solids
CONTROL	1	6.33	7.44	0.85	6.79	7.87	0.86
	2	6.07	7.30	0.83	6.89	8.00	0.86
	3	6.07	7.31	0.83	6.89	7.94	0.87
	Mean	6.16	7.35	0.84	6.86	7.94	0.86
EXPERIMENTAL	4	7.24	8.44	0.86	7.05	8.08	0.87
	5	6.43	7.46	0.86	6.94	7.99	0.87
	6	6.71	7.72	0.87	6.71	7.77	0.86
	7	6.49	7.57	0.86	6.84	7.80	0.88
	8	6.52	7.65	0.85	6.84	7.90	0.86
	Mean	6.68	7.77	0.86	6.88	7.91	0.87
RECOVERY	9	6.49	7.42	0.87	6.89	7.85	0.88
	10	6.18	7.26	0.85	6.89	7.89	0.87
	11	6.04	7.31	0.83	6.92	8.12	0.85
	Mean	6.24	7.33	0.85	6.90	7.95	0.87

TABLE 4

Cell percentages (hæmatocrit method) and plasma protein concentrations of four calves, determined immediately before and at the end of the first exposure to heat (45° C. [113° F.] at low humidity).

		Calf			
		A	B	C	D
Cell percentage (%)	Before heat	31.8	31.5	29.8	36.3
	End of heat	35.0	34.3	37.6	39.0
	Increase	3.2	2.8	7.8	2.7
	Increase(%)	10.1	8.9	26.2	7.4
Plasma protein concentration (g/100 ml)	Before heat	6.68	6.67	7.03	6.86
	End of heat	7.03	6.85	7.45	7.25
	Increase	0.35	0.18	0.42	0.39
	Increase(%)	5.2	2.7	6.0	5.7

logical reactions to those described previously were obtained. Fig. 2 shows that (1) changes in the cell percentage and blood specific gravity parallelled each other, as would be expected, (2) the plasma protein concentration behaved similarly, and (3) exposure to heat clearly caused a rise in the cell percentage and the plasma protein concentration.

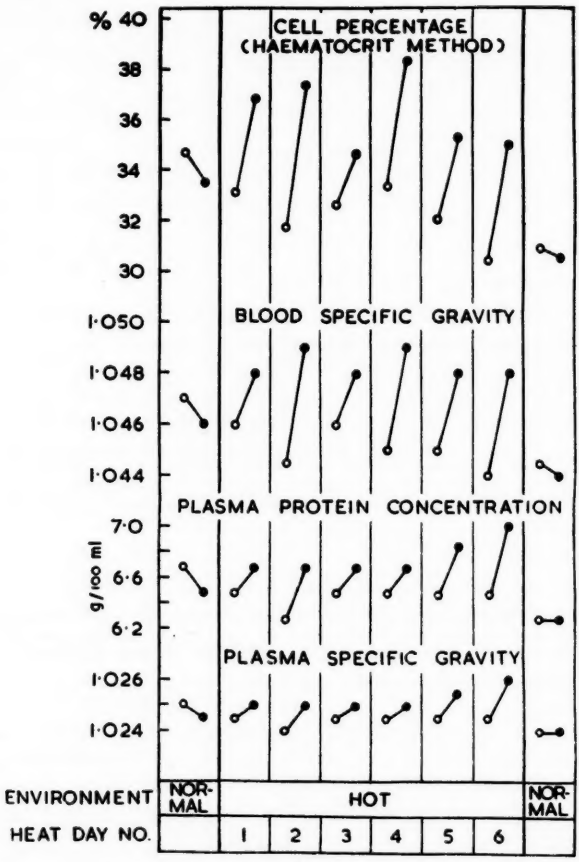

Fig. 2

Hæmatological responses to humid heat (40.0° C. [104.0°F.] dry bulb temperature and 38.1° C. [100.6° F.) wet bulb temperature) of supplementary calf E; measurements taken shortly before (O) and at the end (●) of each exposure.

(6) *Total plasma solids.*

The total amount of plasma solids in circulation, unlike their concentration, was unaltered by the first exposure to heat, but increased during subsequent exposures (Fig. 1). About half-way through the experimental period they began gradually to decrease. The changes in total plasma water were essentially the

same as those in plasma volume (Fig. 1) since plasma consists of over 90 per cent water. The difference in the percentage increase of the plasma solids and of the plasma water from about the fifth day of heat exposure onwards is reflected in the plasma solids concentration. It indicates that since the plasma solids increased more than the plasma water, the concentration of the plasma solids was slightly elevated.

(7) *Rectal temperature, heart rate and respiration rate.*

Detailed information on these measurements will be presented elsewhere. The general effect of the exposures to heat on rectal temperature, heart rate and respiration rate is shown in Table 5. It is apparent that under the heat load

TABLE 5

Rectal temperatures, heart rates and respiration rates of the calves, measured in the climatic room on the first and the last (21st) day of exposure to heat (45.0° C. [113.0° F.] dry bulb, and 27.6° C. [81.7° F.] wet bulb temperature).

Each figure represents the average for the three experimental calves. "Beginning of heat exposure" means: 10 to 15 minutes after entering the heated room.

	Rectal Temperature °C (°F)		Heart rate (Beats/min.)		Respiration rate (Resp./min.)	
Heat Day No.	1	21	1	21	1	21
Beginning of heat exposure	39.4 (102.9)	38.4 (101.1)	99	89	64	81
End of heat exposure	41.8 (107.2)	41.1 (106.0)	158	110	203	185
Increase	2.4 (4.3)	2.8 (4.9)	59	21	139	103
Increase (%)	6.2 (4.2)	7.2 (4.8)	59	24	221	129

imposed on them the animals were unable to keep their body temperatures constant. The average rectal temperature rose from the beginning to the end of the first exposure to heat from 39.4° C. (102.9° F.) to 41.8° C. (107.2° F.) and was still increasing when the animals were removed from the heat. Hence, the heat loss from the body, which at an air temperature of 45° C. (113° F.) and low humidity could only be through evaporation, was not sufficiently large to balance the heat load. The rise in rectal temperature was accompanied by increases in the heart and respiration rates.

Similar observations on the behaviour of rectal temperature, heart rate and respiration rate in the bovine animal exposed to heat, although under somewhat different conditions of environmental temperature and humidity, have been made previously by numerous workers, e.g., Riek and Lee (1948), Brody (1949), Beakley and Findlay (1955*a*, *b*, *c*). Table 5 shows, however, that the responces to heat on the 21st day of exposure were different from those on the first day. On the 21st day of the experimental period the calves were able to finish their five-hour heat exposure with a lower rectal temperature and a lower heart rate than on the first day. Data collected on heat days two to 20 indicated that these

changes in rectal temperature and heart rate developed within approximately the first 10 days of the heat treatment.

The figures for respiration rate, shown in Table 5 under the heading " end of heat exposure " are maximum values, and were recorded during heat exposure but not necessarily at the end of it. The reason for choosing these maximum values instead of the end-of-heat exposure values is that under severe heat stress respiration rate has been observed to fall after having reached a maximum. It may be seen from Table 5 that the maximum respiration rate was kept at a slightly lower level on the 21st as compared with the first day of exposure to heat, again indicating that the animals were under a lessened strain after three weeks heat exposure.

Discussion

The results suggest that the responses of the experimental calves to heat occurred in two different phases. A first phase occurred within the first five days of heat exposure as regards hæmatological values and comprised approximately the first 10 days as regards rectal temperature and heart rate. This first phase was characterized by hæmoconcentration, high rectal temperature and high heart rate. The hæmoconcentration has been shown to be the result of two reactions: (1) an elevation of the volume of the circulating cells and (2) a loss of water from the plasma. These two changes probably reflect a mobilisation of blood rich in cells from blood reservoirs and passage of water from the plasma into the tissues spaces.

That there was an actual increase in the circulating cell volume is also evident when a comparison is made of the relative magnitude of increase in the cell percentage and the plasma solids concentration. Any loss of water from the plasma, as indicated by an increase in the concentration of its solids will, other factors remaining constant, of necessity also raise the cell percentage of the blood. The portion of the increase in cell percentage which would have been produced solely by water loss from the plasma can be computed. Expressed as a percentage of the total rise of the cell percentage observed on first exposure to heat, this portion amounted to 18, 21 and 29 per cent in the experimental animals E_1, E_2 and E_3; to 66, 21, 15 and 48 per cent in the supplementary calves A, B, C and D; and to 19, 25, 35, 13, 38 and 37 per cent in supplementary calf E during six successive heat exposures. The complement of the above figures to 100, i.e., 82, 79 and 71 per cent, etc., of the total observed increase of the cell percentage therefore represents an actual rise in the volume of circulating cells.

In the dog, another haired, panting mammal, Flinn and Scott (1923) found that the blood solids tended to increase as the environmental temperature rose. Since these investigators dealt only with whole blood they were unable to differentiate between the relative importance of cells and plasma as contributing factors to the observed hæmoconcentration which, therefore, they attributed simply to an excessive loss of water from the blood.

Hæmoconcentration has been observed to occur also under the influence of other factors. Bianca (1950) found a rise in cell percentage following the

injection of the adrenaline-like substance "Veritol" in horses, cows, goats and sheep, as well as in the blood of horses which were shot and bled. Both these rises were of a similar order. Five horses averaged a venous blood cell percentage of 32 per cent under normal conditions, 41.5 per cent after an injection of Veritol, and 45.8 to 41.6 per cent during bleeding after being shot. Post-mortem examinations revealed the spleens of the horses to be in a fully contracted state. Since it may be assumed that in agonic death the body is suffering both from lack of oxygen and an excess of carbon dioxide the response is consistent with the finding that the hæmoglobin concentration rises during acute hypoxia (Kramer and Luft, 1951) as well as during inhalation of very high concentrations of carbon dioxide (Billings and Brown, 1955). In both these investigations, which were conducted on dogs, the increased hæmoglobin levels could be traced to splenic discharge. Finally it was observed that calves in a state of excitement showed an elevated cell percentage in their blood (Bianca, unpublished). These findings indicate that hæmoconcentration is a feature common to a variety of conditions of stress and suggest that adrenaline is the mediating factor.

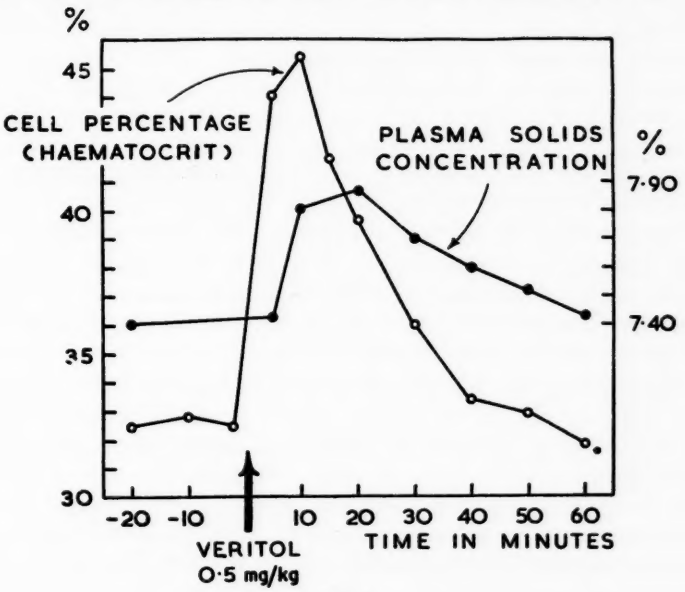

Fig. 3
The effect of an intravenous injection of an adrenaline-like substance ("Veritol") on the cell percentage (hæmatocrit method) and plasma solids concentration of supplementary calf E.

If heat were simply another environmental stimulus comparable to those mentioned above then it should be possible to simulate its action by using adrenaline. This was done with supplementary calf E. As may be seen from Fig. 3, following the intravenous injection of Veritol, there occurred a sharp transient rise in the cell percentage and a similar rise in the concentration of the

plasma solids. It is interesting to note that the rise in cell percentage slightly preceded the rise in plasma solids concentration. This might indicate that the sympathomimetic action of the drug and the consequent mobilisation of red cells elicited an increased transfer of water from the blood to the tissues.

A second phase extended over the remaining part of the experimental period. In it the plasma volume tended to increase. Hæmoconcentration had ceased except for a slightly increased concentration of the plasma solids. This, however, was shown to be due to an augmentation of the solids in the plasma rather than to a loss of water from it. Rectal temperature and heart rate in successive exposures to heat gradually rose to a less high level than in the first phase, indicating that the animals were under less strain; that, in fact, they were becoming acclimatized to heat.

It thus appears that the initial transitory hæmoconcentration observed in the experimental animals was a response to stress in general rather than to heat specifically, and that the behaviour of the calves during the second phase of heat treatment would be a more adequate guide to their response to heat itself.

The slight increase in plasma volume observed in this second phase could be indicative of a slight peripheral vasodilatation. However, no peripheral vasodilatation appears to have developed in calves A, B, C and D since the specific gravity of their plasma did not show any decrease during the first hour of an exposure to an atmosphere of 45° C. (113° F.) and low humidity. Had there been extensive vasodilatation, a decrease in the plasma specific gravity should have been expected to develop within approximately the first half-hour of heat exposure, due to an influx of extravascular fluid (Bass and Henschel, 1956).

The findings that (1) there was no decrease in total plasma water, (2) the calves were unable to prevent their body temperatures from rising considerably in the hot-dry atmosphere, and (3) the calves did not show marked thirst, suggest that no excessive fluid loss had occurred.

It might be argued that actually there was such an excessive water loss to the environment but that it was not reflected in the behaviour of the blood because water was supplied to the blood at a similar (increased) rate as it was lost from it. This water could have come from two sources: from the digestive tract or from the extravascular tissue spaces. Since it is known (Cizek, 1954) that in the digestive tract of the ruminant considerable amounts of water may be stored, it is conceivable that a calf during a 5-hour exposure to heat could balance an excessive evaporative water loss by water replacement from the digestive tract. Yet, an increase in the consistency of the fæces, which might have followed was never observed in the present work; on the contrary, during severe heat stress, the fæces were soft and often liquid. It is doubtful also whether there was an increased transfer of water from the tissue spaces into the blood (1) because according to Moyer (1952) fluid is drawn more rapidly from the plasma than from the extravascular fluid spaces which, under the assumption of an excessive evaporative water loss, should have led to a depletion of plasma water, not observed in the calves, (2) because an increase

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in the concentration of the interstitial fluid following an excessive water loss from it should have been accompanied by a much larger increase in the concentration of the plasma. In man at least, during dehydration, the plasma loses much more water than the rest of the body, expressed on a weight per weight basis (Adolph, 1947).

The hæmatological findings would thus indirectly suggest that peripheral vasodilatation and sweating did not develop to a marked degree in the calves exposed to heat.

It is interesting to follow the teleological speculation that in an atmosphere of approximately body temperature peripheral vasodilatation unaccompanied by sweating would be ineffective since it would mean that more blood from the warm interior is shifted to an equally warm periphery without any transfer of heat. Under the same environmental conditions sweating unaccompanied by peripheral vasodilatation, if possible to a marked degree, would be less effective because of the lowered heat transfer from the interior to the surface. It would thus appear that in severe heat peripheral vasodilatation and sweating were functionally linked.

Finally, the reactions of the experimental calves will be briefly considered in the light of Selye's concept of the "general adaptation syndrome" (Selye, 1950). There is agreement between Selye's stage of alarm and the first phase of heat exposures described in this paper in that they both are characterised by hæmoconcentration and a low resistance to the specific stressor agent to which the body is exposed, which in the present experiment was heat. Features similar to Selye's stage of resistance appearing in the second phase of the present experiment are the decline in hæmoconcentration from the previous stage, the tendency for an elevated plasma volume to occur and increased resistance to the specific stressor agent. No comparison is possible with the last stage of the general adaptation syndrome of Selye, the stage of exhaustion, because the present experiments apparently did not last long enough to allow deterioration to develop.

According to Selye the hormonally-induced changes occurring at the beginning of an acute exposure to a stressor agent which affects large portions of the body, represent an adaptive reaction which comprises the "learning" of defence against future exposures to stress. If this holds true for the present experiments then the initial hæmoconcentration must have been an early part of the acclimatisation process.

Summary

1. Three calves were individually exposed in a climatic room to a hot dry atmosphere (45° C. (113° F.) dry bulb temperature, 27.6° C. (81.7° F.) wet bulb temperature) for up to 5 hours each day over a period of 3 weeks (experimental period). Before and after this they spent 2 weeks in a neutral thermal environment (control and recovery periods). Three other calves were permanently kept as controls under normal atmospheric conditions.

2. During all three periods hæmatological determinations were made at 5-day intervals on all six animals. During each exposure to heat, rectal temperature, heart rate and respiration rate were recorded in the three experimental animals.

3. The results of the hæmatological determinations collected during the control period in all six calves are presented as "normal values" and compared with corresponding data in the literature.

4. Exposure to heat produced hæmatological changes which, although not of a statistically significant order, showed the following trends: on the first day of heat exposure there occurred hæmoconcentration which was due mainly to an increase in the circulating cell volume and in a lesser degree to a loss of water from the plasma. In subsequent exposures hæmoconcentration ceased and at the same time plasma volume increased. As the increase was greater in the plasma solids then in the plasma water, the concentration of the plasma solids remained slightly elevated throughout the experimental period.

5. With successive exposures to heat the experimental animals became acclimatised as shown by lower levels of rectal temperature, heart rate and respiration rate.

6. It is concluded that the hæmoconcentration observed at the beginning of the period of heat exposures was a response to stress in general rather than to heat in particular, and that such fluid loss as did occur from the animals was insufficient to affect markedly their fluid exchange as reflected in the volume and hydration of the blood.

7. The results are discussed in the light of Selye's concept of the "general adaptation syndrome."

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THE USE OF CHOLINE CHLORIDE AS A LIPOTROPHIC AGENT IN THE TREATMENT OF BOVINE LIVER DYSFUNCTION

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Introduction

THE "ketosis" syndrome when accompanying the "milk-fever complex," presents a common and often serious complication to the hazards of parturition in cattle. Veterinary surgeons familiar with the condition will remember that it occurs frequently in Channel Island cattle and there is only a partial and temporary response to calcium, magnesium, phosphorus and dextrose therapy. Repeated therapy appears to evoke progressively reduced responses until the animal becomes comatose and succumbs. In such cases the most prominent lesions at post mortem examination are confined to the liver and kidneys. These organs show extensive fatty changes and are enlarged, pale in colour and greasy to the touch.

Fisher (1924) and Allan et al (1924) showed that depancreatised dogs maintained on insulin and fed certain mixed diets developed enlargement and fatty infiltration of the liver. They pointed the way to an appreciation of the effects of choline upon animal metabolism. Hershey (1930) reported that egg-yolk lecithin in crude form prevented the development of fatty livers in such cases. Best and others (1932 and 1934) demonstrated the lipotrophic activity of pure lecithin with choline as its active component and showed that many forms of fatty change in the livers of rats associated with dietary imbalances could be prevented by the administration of choline. Best also suggested that choline accelerated the oxidation of fat in the liver and McHenrey (1935) traced the inter-relationship between choline and vitamin B_1, showing that excess of the latter and deficiency of the former results in fat deposition in the liver. Since then numerous references have been made to the role of choline in metabolism in most species of animals. Maynard (1950) stressed the importance of dietary deficiency of choline in the production of a variety of disorders in various animals such as growth failure, fatty livers, hæmorrhagic kidneys and poultry perosis. He also described the essential role of choline in fat metabolism in the liver preventing the abnormal accumulation of fat either by promoting its transport as lecithin or by increasing the utilisation of the fatty acids in the liver itself. It is also essential for the formation of acetyl-choline necessary, amongst other things, for the transmission of certain nerve impulses.

Best (1950) in his admirable review on protection of liver and kidneys by dietary factors emphasised the importance of distinguishing between lesions which are primarily due to choline deficiency and those which are secondary to deranged function of the liver or kidney. Fatty livers and kidneys and hæmorrhagic kidneys which are primary lesions in this context, can be prevented

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completely by choline. Fatty changes and the early cirrhosis which follow can be reversed by choline administration, but advanced changes in liver and kidney structure are unlikely to be reversed.

In cattle the bio-chemical aspects of the syndrome are necessarily complex, but it appears that excessive infiltration of fat into hepatic cells leads to liver dysfunction inducing a state of toxæmia which is superimposed upon the primary metabolic disorder. In severe cases the toxæmia may be responsible for symptoms attributed mistakenly to hypocalcæmia alone.

In some instances, partial relief is obtained by the provision of readily available sugar, relevant hormones such as Adreno-Cortico-Tropic hormone and the Cortisone group, or merely by the transient buffering effect of calcium borogluconate as routine therapy. Relapses, however, are common and continued treatment on these lines merely serves to prolong the duration of the illness. Mild cases, if only through the beneficial effects of starvation depleting liver fat, make a slow and uneconomic recovery. Often the subsequent lactation fails to reach the expected standard.

As ketosis in varying degree is a common accompaniment to parturition even in cows which appear clinically normal, it is likely that some degree of fatty change in those organs described, is present. In its clinical manifestations the syndrome has much in common with the well-recognised condition of pregnancy toxæmia of sheep.

The criterion of successful treatment of cases where this type of liver dysfunction is thought to be present, is the rapid reduction of the state of fatty infiltration of liver tissue and the restoration of liver metabolism towards normal levels. To this end, the lipotrophic properties of choline have been tested in a series of 10 individual cases.

Methods

Suitable cases were selected on the basis of clinical signs and failure to respond satisfactorily to conventional therapy for " milk-fever." Care was taken to eliminate as far as possible the presence of other conditions which might have produced a similar picture. This necessity was stressed by Lewis (1955) who also advocated the institution of treatment at the earliest possible moment in all metabolic diseases, in order to inhibit irreversible pathological changes. The clinical features of the syndrome are illustrated by the following typical case history :—

The subject was a 6½-year-old Jersey cow which had calved unaided some eight hours before being found semi-comatose by the attendant. The cow was generally depressed but she was able to lie on her sternum with her chin tucked into the left flank. The ears, horns, body surfaces and extremities were cold to the touch and the muzzle was dry. The pupils were dilated and when the head was pulled forward the cow was unable to hold it erect for more than one or two minutes. The coccygeal muscles, the anus and the vulva were relaxed. Fœtal membranes were protruding, but were found to be free

and lying loose in the uterus and vagina. The temperature was subnormal (99.4° F.) the respiration was shallow and the cow emitted an occasional slight moan on expiration.

A diagnosis of post-parturient hypocalcæmia was made and after blood samples had been taken, 400 cc. of a 20 per cent solution of calcium borogluconate were injected intravenously; a similar dose was given subcutaneously.

Within a few minutes the body reflexes appeared to improve in strength and a small quantity of hard fæces was passed. Muzzle and conjunctival secretions appeared, but it was noted that within 20 minutes the muzzle had become dry again. The fœtal membranes were removed and the cow made comfortable.

About 6 hours later she was relapsing towards the original state of depression. The attendant reported that, at times, she had appeared brighter but soon relapsed. 400 cc. of a 20 per cent solution of calcium borogluconate with phosphates, magnesium salts and 20 per cent dextrose were administered by slow intravenous injection, and half a grain of strychnine hydrochloride subcutaneously. The results were disappointing. The animal insisted on maintaining its recumbent posture and depressed demeanour.

Some 4 hours later the picture appeared to have deteriorated and choline therapy was applied. 25 grammes of choline chloride dissolved in 250 cc. of sterile water were injected subcutaneously, and the site of administration was massaged vigorously. Within half an hour, the patient was brighter. The muzzle was moist and the head was held erect. A second dose of 25 grammes of choline chloride in water was then administered by nasal tube. Recovery was maintained and within 12 hours the cow was standing, able to eat and take an active interest in her surroundings. No further treatment was applied and although the udder secretion was very yellow and viscid for 48 hours, recovery was uneventful.

Analysis of the blood sample gave the following results:—

Calcium	7.0	mgms.	per	cent	serum
Magnesium	3.4	„	„	„	„
Ketones	20.0	„	„	„	„
Inorganic P.	1.4	„	„	whole	blood.

Results

Of 10 cows treated in the manner described above, nine responded in similar fashion. The group represents individual cases seen since 1947, and the dosage of choline in each case was 25 grammes initially followed by a further 25 grammes given from two to four hours later. The group comprised four Jerseys, one Jersey/Shorthorn, three Guernseys and two Ayrshires. One Jersey cow was affected at her third parturition, but the remaining animals had calved for the fourth time or more. The oldest animal in the group was a crossbred Jersey which was affected immediately after her seventh parturition. One

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Guernsey, failed to respond to any therapy and on examination post mortem, marked fatty changes in both liver and kidneys were found despite the choline therapy which was included as part of the treatment. This cow showed signs of toxæmia within four hours of calving and died within 12 hours.

The choline chloride was administered by the oral route in the above cases with the exception of Nos. 2, 7, 8 and 10. In these cows the initial dose only was given by subcutaneous injection.

No.	Cow	Age in years	No. of last Parturition	Result
1	Jersey	5½	4	Recovered
2	Jersey	5	3	"
3	Jersey	6½	5	"
4	Jersey	7	5	"
5	Jersey/Shorthorn	9½	7	"
6	Guernsey	8	6	"
7	Guernsey	6½	4	Died
8	Guernsey	6½	4	Recovered
9	Ayrshire	7	5	"
10	Ayrshire	6½	4	"

Discussion

There is no evidence at the moment that fatty liver in the recently calved cow is due to a dietary deficiency of choline, but the exigencies of advanced pregnancy, responsible as they are for deficiency of many types, are likely to lead to a shortage of choline either relative or absolute. Liver biopsy samples might indicate a change in the histological state of the liver even when there was no clinical evidence of functional disorder.

The chloride of choline was chosen as a therapeutic agent because of its availability and comparatively low cost. Solutions are very alkaline and parenteral administration was avoided when possible, but on those occasions when subcutaneous injections were given no local reaction was observed. The salt, which is deliquescent, was dissolved in water immediately before use.

The dosage was based upon proportional translation of the human dose. For an average sized animal 25 grammes were given, but higher rates may be necessary in larger animals or advanced cases. It was the practice to give a second dose some four hours after the first, but ideally, small repeated doses would be more satisfactory. The transient effect of quantities as small as 5 grammes was confirmed by Price (1956) when only single or double administration is employed. He used a 25 per cent sterile solution of choline chloride by the intramuscular route only, and in no instance was a local reaction noticed subsequently.

The one animal which failed to respond to treatment was probably advanced to such a degree that the dosage and frequency of administration of choline employed was grossly inadequate. It may not have been possible to interrupt the vicious circle of events quickly enough to forestall the fatal toxæmia.

While the individual cases described above lack experimental control, the clinical features of the syndrome are definite enough to provide indications for therapy of this type. It is not suggested that the use of choline can supplant other methods of combating the ketosis syndrome, but it is felt that the lipotrophic action of the drug may be valuable as an adjunct to therapy with A.C.T.H. or other preparations. Wider applications to other conditions associated with abnormal fatty change in organic parenchyma may also be considered.

Summary

The use of choline chloride as a lipotrophic agent in the treatment of post-parturient fatty infiltration of the liver of the cow is discussed. The successful treatment of nine out of 10 cases, diagnosed clinically, is described and the relevant literature in relation to experimental work on laboratory animals is reviewed in support of the hypothesis.

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PRELIMINARY REPORT ON THE USE OF NEW HÆMOSTATIC MATERIALS. GELATIN SPONGE AND GELATIN SPONGE IMPREGNATED WITH DEQUADIN CHLORIDE

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SUCCESSFUL surgical intervention depends in great measure upon the adequate control of hæmorrhage.

In spite of the greatest care surgeons are faced some times with hæmorrhage which is difficult to arrest or control by the use of instruments. Many hæmostatic agents have been formulated and I have tried a number. In my experience most of them effectively control the immediate situation but their after effects are a disadvantage in that they promote local irritation and an ischæmia which are deleterious to the process of good healing.

The chief requirements of a hæmostatic agent are that it should : (a) prevent oozing or slight bleeding, (b) cause no localised irritation or reaction, (c) be absorbed, (d) not act as an allergen, (e) not interfere with the normal healing process, (f) and be sterile.

Recently I have had the opportunity of testing a material which appears to satisfy most of these points. One product is a gelatin sponge * and the other the same gelatin sponge impregnated with 0.1 per cent Dequadin Chloride † (decamethylene—bis 4 animo-quinaldinium chloride). They are packed in sterile containers. Babbs *et al.* (1956) report that this compound inhibits the growth of gram-positive, gram negative and acid-fast bacteria and fungi, including Candida albicans. Dequadin Chloride is a synthetic preparation which was evolved during investigations upon the landexium group of synthetic muscle relaxants. It was noticed to have marked antibacterial activity. Dequadin Chloride is intended for local application either as a wound dressing (Fowler & Jones 1956) or impregnated in gelatin sponge. It is not used systemically, therefore sensitisation of the individual animal or the establishment of strains of bacteria resistant to antibiotic systemic therapy does not constitute a hazard.

Gelatin sponge impregnated with 0.1 per cent Dequadin Chloride has been used extensively in dental surgery with excellent results, Trotter *et al.* (1956). A preliminary trial in canine clinical surgery seems to indicate that both preparations may find a place in veterinary surgery.

The following brief reports indicate the varying ways in which the preparations can be used.

* Sterispon.
† Dequaspon.

A Greyhound bitch, four years of age, was presented with a swelling on the medial aspect of the distal radial epiphysis. X-ray films indicated neoplastic tissue and it was decided to do a biopsy. Under local anaesthesia a small amount of tissue was removed but a profuse hæmorrhage occurred at the site of the incision. The application of hæmostatic forceps failed to control the hæmorrhage. The incision was packed with two 1 in. squares of gelatin sponge impregnated with 0.1 per cent Dequadin Chloride and the hæmorrhage was arrested almost immediately.

A Gordon Setter bitch, four years was presented. A flank incision was made to investigate a recurrent abscess in the region between the seventh and last rib on the left side. A considerable amount of fibrous tissue and a section of the latissimus dorsi muscle was excised. Six grass awns were removed from the external intercostal muscles. During this dissection a circular area approximately 20 cms. in diameter was exposed and there was a considerable amount of capillary oozing. Four pieces of gelatin sponge, each 3 in. square, were placed at various points over the exposed area and pressed firmly on to the bleeding surface. The hæmorrhage ceased promptly and the skin incision was closed completely. No reaction occurred and only a few ml. of sterile serum had to be drained off the following day. No reaction was observed.

In tonsillectomy the use of a 1 in. square of Gelatin sponge impregnated with 0.1 per cent Dequadin Chloride, placed in the crypt after the tissue has been dissected out, and secured by a catgut suture, has been found to control hæmorrhage adequately. No reaction has been observed.

Gelatin sponge has been laid over the exposed tissues following mastectomy and the removal of other subcutaneous neoplasms. The speed with which capillary oozing is arrested is most gratifying.

These materials may also have a use in veterinary dentistry, although persistent hæmorrhages following extractions are rare. Severe hæmorrhage was encountered following the removal of an upper incisor tooth in a ten-year-old mongrel dog. The cavity was packed with a 1 in. square of gelatin sponge impregnated with 0.1 per cent Dequadin Chloride. An effective clot was produced quickly and it remained *in situ* without difficulty.

Although the writer has not used this material to arrest hæmorrhage following abdominal surgery, the tissue has been placed over potential bleeding points, e.g., over the ovarian artery following ovario-hysterectomy and following excision of a carcinomatous growth involving the left lateral and left central hepatic lobes. No evidence of hæmorrhage and no local or generalised reactions were observed.

Summary

The use of a new hæmostatic gelatin sponge and the same sponge impregnated with 0.1 per cent Dequadin Chloride is discussed and a cross-section of cases treated is described.

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NOTES ON THE CAMEL DERIVED FROM A STUDY OF THE CUNIEFORM SCRIPT

By R. H. A. MERLEN

THE Assyrians grouped together under the sign of the Ass the three great beasts of burden, the horse, the camel and the onager (Brit. Vet. J., March, 55, p.128). In the same way but with less reason, the Chinese under Radicle 187 "maa," the "horse" did likewise as regards the camel, mule and ostrich.

At the time when Semitic phonetic values were being given to the ideographs, the significance, if not the pronunciation, of the antique originals was being forgotten rapidly and in the case of the horse the word "sus," or "feres," came to have little to do with the word for word translation of the ideograph, "Imeru matu Ra" (The Donkey from the land of Ra) and which perhaps implied that the early inhabitants of Babylona associated the horse with the plains of Turkestan or at least with the banks of the Volga (Flumen Rha).

The ideograph for "camel" provides a conundrum of no mean order because in this case the basic Semitic "jemel" is applied to a cunieform combination reading "Imeru tiamat" and the question arises what on earth can have induced the early Babylonians to call the camel, "The donkey of the Sea"? *(It should be noted that "tiamat" is completely unconnected with "Tiamat," "the primeval chaos," a phonetic value which is applied to quite another ideograph altogether).*

In attempting to connect "camel" and "sea," a number of weird *non sequiturs,* which cut across half-a-dozen tongues and idioms of thought and expression, immediately spring to mind, the most obvious being some bowdlerised version of the "ship of the desert." It might be that the sight of a herd of two humped camels gathered around a well may have inspired an early poet with the idea that they provoked some semblance to the surface of the Caspian Sea on a "choppy" day. This sort of conjecture must be handled with the greatest care.

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Another approach is to assume that the connection with the sea is meant to imply that the camel came from the sea, or from overseas, in the same way that the worship of Venus, imported into Europe by the seamen on Middle East trading vessels, is always alluded to by the symbolic "rising of Venus from the waves." Asiatic legends provide many examples of horses coming out of the sea, or from large inland lakes which are the "sea" to the inhabitants of vast Continents who have never had the chance to visit the Ocean. Many a famous horse is said to have made his *debut* on the steppes in this way, or to have been sired by a stallion which quietly surfaced one fine night, waded ashore and promptly covered one of the good-looking local mares. There is no similar legend connected with the camel, nor can the camel be considered as coming "from the lands beyond the sea" because in the case of Babylon this would imply the Persian Gulf which could only contribute the single-humped animal.

In this connection it is worth remembering that the Mongolian word for camel is "tyemé." Differences in speech and in the meaning of words in the frontier regions which converted "John" into "Ivan" and gave the Goths "albrandos" for "elephantus" might well have converted "tyemé" into "tiamat" especially since in Semitic times the temptation to add the feminine ending "at" to an unknown word must have been very strong. It might have converted jibberish into something in common use. Circumstances at least bear this supposition out; the two-humped camel is a denizen of Central Asia and as in those far-off times wild herds of camels still roved the Asian wilderness it is conceivable that the animal was introduced into Babylonia by those who were the first to domesticate it. If this supposition is correct there would seem to be some grounds to support the suggestion of existence of a word borrowed from the Mongolian in the early Babylonian language.

THE HÆMATOLOGICAL EXAMINATION OF THE BLOOD OF NORMAL SHEEP

By HUSSIEN REDA, M.V.Sc., and A. F. HATHOUT, M.V.Sc. (Cairo),
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THE purpose of this work is to present the blood picture of Egyptian sheep to give a help for those interested in sheep breeding. Moreover, changes can be easily detected when compared with these findings during disease and treatment can be prescribed accordingly.

The animals subjected to this work were 60 sheep belonging to both Breeding and Feeding Sections in the Faculty of Agriculture. The animals selected to present this picture were of high standard and in good health. They were given a well-balanced ration and were all exposed to sunlight and lived in healthy sheds. The sheep were all free from parasitic infestation, skin diseases or any other specific diseases.

The animals were classified as follows:—

Group 1 includes new-born lambs—1-60 days
Group 2 includes lambs—2-12 months
Group 3 includes young sheep—1-2 years
Group 4 includes adult sheep—2-5 years.

Technique

Blood specimens were collected from the marginal vein of the ear. The first drop was wiped, and the second drops were used for:

(1) The differential count of leucocytes.
(2) The red blood corpuscles "Erythrocytes."
(3) The white blood corpuscles "Leucocytes."
(4) The Hæmoglobin percentage.

Blood films were stained by the panoptic method using May-Gruenwald stain followed by Giemsa stain. In counting cells a Neubauer hæmocytometer was used. The Sahli Hæmoglobimometer was chosen for determination of hæmoglobin.

Normal Blood of Sheep

The Red Blood Corpuscles.

The new-born recorded a maximum of 12.780 million, a minimum of 9.080 million, with an average of 10.920 million per cu. mm.

The count for the adult sheep ranged between 9.210 million for the maximum and 7.960 million for the minimum, with an average of 8.585 million per cu. mm.

Lambs and young sheep recorded average of 10.598 million and 9.735 million per cu. mm. respectively, while their maximum counts were 11.920

million and 10.450 million per cu. mm., their minimum counts were 9.240 and 9.020 million per cu. mm. respectively.

In the four groups, the counts were high in new-born lambs and low in adult sheep, while lambs and young sheep occupied a middle position between the two groups.

Finally, the averages recorded by the four groups are: 10.930, 10.598, 9.735 and 8.585 million per cu. mm. respectively. From the findings, one concludes that young animals have a higher red cell count.

Cohnstein (1884) gave a count of 12.090 million per cu. mm. of R.B.Cs. in sheep. Bethe (1892) gave a count of 9.133 million per cu. mm. in sheep. The average number of red corpuscles given by Woltmann (1895) was 8.000 million per cu. mm. in sheep. Storch (1901) found the average for adult sheep 10.470 million, while for lambs he found 11.032 million per cu. mm. Warthin (1903) recorded 12.5 million per cu. mm. in sheep. Giltner (1908) found higher amounts in two normal male sheep. The red corpuscles were 9.120 and 11.500 million per cu. mm. Wetzl (1910) found the red corpuscles in normal sheep to vary from 8.008 to 9.272 million per cu. mm. Sussdorf stated that the lamb has not less than 13-14 million. The average for adult sheep is given from 8-12 million. Fourie gave a count of 5.6 million, and Andrew gave a count of 7.2 million per cu. mm. of R.B.Cs. in sheep. Holman (1945) found that sheep gave a count of 11.5-12 million per cu. mm.

The number of red corpuscles was found to be higher in males than in females. In this work the male lambs gave an average count of 10.535 million and the female lambs an average of 9.875 million per cu. mm., while the rams gave an average of 8.560 million, and the ewes an average of 8.000 million per cu. mm.

Storch (1901) found an average of 11.183 million corpuscles in rams, 9.839 million in wethers and 10.396 million in ewes. Wiendieck (1906) found in man the average of red corpuscles is 5.000, while the average for women is 4.500 million per cu. mm.

The Hæmoglobin Percentage

The percentage varied from 72 to 54 in all groups. The averages recorded for the four groups being 70.5 for new-born, 72 for the lambs, 62.5 for the young sheep, and 54 for adult sheep. The hæmoglobin percentage tends to be high in young animals and low in adults.

Giltner (1908) found in two normal sheep that the hæmoglobin was in each 85 per cent. Wetzl (1910) found the amount of hæmoglobin in normal sheep to vary from 47 to 63 per cent. Holman (1945) recorded 12.6 gm. for normal sheep (85 per cent).

The White Blood Corpuscles

The number of the white blood corpuscles per cu. mm. for sheep as a whole varied from 8,585 to 10,000. Averages being 10,000 for new-born lambs, 8,500 for lambs, 9,200 for young sheep and 8,000 for adult sheep.

XUM

The lowest averages recorded was that of the adult sheep. The highest average was recorded by new-born lambs, then it is observed that the average tended to be lowered in lambs and increased a little in young sheep.

Different workers, however, gave varying results. Bethe (1892) recorded 4,140 per cu. mm. for sheep. Woltmann (1895) recorded an average of 8,000 W.B.Cs. per cu. mm. for sheep. Storch (1901) recorded 9,420 for adult sheep and 10,198 for lambs. Warthin (1903) gave a count of 7,000 for sheep. Giltner (1906) recorded a count between 5,300 and 11,900 W.B.Cs. for sheep. Burnett (1917) discussed that the number of leucocytes is high in the young with a high percentage of lymphocytes.

The Differential Count

(1) *The Neutrophile Granulocytes.*

The neutrophile cells, according to their percentages occupy a second place to the lymphocytes in all groups except animals of group I " New-born lambs," where the neutrophile cells recorded a higher percentage than the lymphocytes.

(2) *The Lymphocytes.*

The lymphocytes occupied as a whole the first place with the exception of the new-born lambs as was stated under the neutrophiles.

(3) *The Eosinophile Granulocytes.*

These cells are not so numerous as the lymphocytes and neutrophiles. The percentage of these cells in circulating blood in the four groups varied widely. According to the findings, the percentage of the eosinophiles is observed to increase in a parallel direction with the age, lowest in the young animals and highest in adults.

(4) *The Basophile Granulocytes.*

These cells are the scantiest in the blood, they were not demonstrated in the majority of the 60 cases examined.

(5) *The Monocytes.*

These cells are not very numerous in the blood. They showed high counts in young sheep and low counts in new-born lambs.

The following table records the averages of the different counts in the four groups :—

Group of animals	R.B.Cs. million	H.B. %	W.B.Cs.	Neut. %	Lymph. %	Eos. %	Bas. %	Mon. %
New-born lambs ...	10.930	70.5	10.000	64.5	44.0	0.2	0.1	1.2
Lambs	10.598	72.0	8.500	39.0	55.0	2.5	0.5	3.0
Young sheep	9.735	62.5	9.200	43.0	48.5	4.0	0.2	4.3
Adult sheep	8.585	54.0	8.000	41.0	50.0	5.7	0.3	3.0

It is interesting to record two of the findings on sheep reported by investigators.

Author	Neut.	Lym.	Eos.	Bas.	Mon.
Burnett (1917)	37	53	1.7	0.3	8
Holman (1945)	17	74	5.0	1.0	3

XUM

Summary

Sixty normal cases were examined for R.B.Cs., W.B.Cs., H.B. percentage and differential count.

The number of R.B.Cs. of sheep per cu. mm. of blood varies with the age of the animals. The counts being higher in new-born and low in adult sheep, while lambs and young sheep occupied a middle position. The count of male sheep is higher than in females.

The hæmoglobin percentage as in the red cell count tend to be higher in young animals and low in adults.

White blood corpuscle counts also behave in a similar manner, being higher in new-born and low in adult sheep.

The neutrophiles recorded a higher percentage than the lymphocytes in Group 1 (new-born).

The lymphocytes occupied as a whole the first place in all groups with the exception of the new-born.

The eosinophiles increase in a parallel direction with the age, lowest in the young and highest in adults.

The basophiles are the scantiest cells in the blood.

The monocytes are not very numerous and are low in the new-born.

The findings recorded in this work are in close agreement with other workers in many instances.

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A FEW RULES IN DOSE ESTIMATION FOR YOUNG AND ADULT ANIMALS

By ABD EL AZIZ SHARAF, M.V.Sc.

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WHILE the most accurate system of dosage is generally conceded to be to estimate the dose to be administered to a given species of animal on a drug-weight or volume/body-weight basis, there is no fixed rule adopted in practice for calculating the dosage for animals of the same species that have not yet reached maturity. In the experience of the present writer, it is then best to reckon the dosage either according to the age or according to the weight of the younger animal in relation to the estimated adult dose. It is not always convenient to weigh animals and very difficult to form an exact estimate of the body weight, especially in the case of the larger domestic animals. Body weight is therefore suggested as the guide in calculating dosage of young animals in canine practice, and age in the case of those of the larger animals. The applicability of the following rules has been recently investigated by the present writer:—

A. CANINE PRACTICE

Rule 1.—Dose for young dog of any breed. Calculate according to:—

$$\frac{\text{Weight of young dog}}{\text{Average weight of an adult of same breed}}$$

Rule 2.—Dose for an adult of a given breed. Take the fox terrier breed as the standard; average weight of adult = 20 lb. Then calculate according to:—

$$\frac{\text{Weight of the adult of the given breed}}{\text{Weight of a standard adult fox terrier (20 lb.)}}$$

where, for example, toy terrier = 4 lb., pomeranian = 8 lb., spaniel = 12 lb., poodle = 15 lb., bulldog = 40 lb., armant = 50 lb., greyhound = 60 lb., pointer = 60 lb. alsatian = 60 lb. and great dane = 120 lb.

B. LARGE ANIMAL PRACTICE

Rule 3.—Substituting age for weight in Rule 1, calculate the dose as a

$$\text{fraction of the adult dose} \times \frac{\text{age of the young animal}}{\text{adult age of the species or breed}}$$

Hence, for example, the dose for a three-month-old calf would be:—

$$\frac{3 \text{ months}}{2 \text{ years}} = \tfrac{1}{8} \text{ adult cattle dose;}$$

for a nine-month-old foal:—

$$\frac{9 \text{ months}}{3 \text{ years}} = \tfrac{1}{4} \text{ adult horse dose;}$$

for a four-month-old sheep :—

$$\frac{\text{4 months}}{\text{2 years}} = \frac{1}{6} \text{ adult sheep dose.}$$

Discussion

In the application of these apparently simple rules there are several important considerations to be borne in mind which, on occasion, call for some modification. Among these considerations, the following may be mentioned :—

(1) The age at which an animal of a given species reaches the adult stage differs, sometimes markedly, depending upon the breed, the climate, and the mode of feeding. The estimated dose for the younger animal needs to be modified accordingly.

(2) The degree of accumulation of adipose tissue, which is also related in part to the above circumstances, needs to be taken into account inasmuch as the adult dose may be allowed to be the same whether the animal is in a poor state of nutrition or is excessively obese. The average adult dose must be looked upon, therefore, as the dose required by an adult animal of the species indicated, its body weight being that of the animal in an average state of nutrition.

(3) If it were practicable always to weigh animals of the larger species, the doses administered to horses and cattle, for example, could be readily regulated as in the case of dogs. For want of accurate weighing, arbitary averages are usually given for the adults; for example, brown Swiss cattle, 1,500 lb.; Arab horses, 1,000 lb.

(4) In the case of highly toxic drugs, care has to be taken to safeguard against individual variations and idiosyncrasies and the toxicity rate.

(5) Sex needs to be taken into account, for as a rule males are heavier than females; for example, a Jersey cow may weigh 900 lb. and a Jersey bull 1,500 lb.; an Egyptian cow-buffalo may weight 1,200 lb. and a bull-buffalo about 1,500 lb. Yet, the required dose may not vary correspondingly.

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REVIEWS

DIE SCHWANGERSCHAFTSDIAGNOSE BEIM RIND, by Richter-Tillmann. Stuttgart: Verlag Paul Parey. 5te. Aufl., 1956. Pp. 107. DM 9.60.

THIS little book is devoted to the diagnosis of pregnancy in cattle. There are introductory chapters on the anatomy and physiology of the genital tract of the cow and these are followed by an account of the clinical methods that may be used in the field. The largest and most important part consists of a month by month description of the changes that occur as pregnancy proceeds and concludes with a discussion of the signs that indicate the approach of parturition.

This is essentially a book for the clinician: laboratory techniques are dismissed in a few words and very properly emphasis is concentrated on the recognition of pregnancy during the first few weeks, since it is obvious that accuracy in diagnosis at this stage presents the greatest difficulty. The ability to recognise early pregnancy or its absence may be of considerable economic importance to the farmer and reliability in this can contribute greatly to the reputation of the practitioner. There can be few engaged in cattle practice who would not benefit from reading this account, for even in such an essentially practical subject there is always much that can be learnt from the experience of an undoubted expert.

The many excellent illustrations add to the value of the book.

TIERARZTLICHE OPERATIONSLEHRE (Textbook of Veterinary Surgery), by E. Berge and M. Westhues, 1956. Pp. xi + 374. Berlin: Paul Parey. Price D.M. 29.60.

THIS book is a combination of two previous textbooks—Pfeiffer—Westhues "Operationskursus" and Röder-Berge "Chirurgische Operationstechnik." These were in their 17th and 9th editions respectively and the present work is called the 27th edition.

The book is of handy size, printed on good quality paper and well illustrated by 264 diagrams. In the first 80 pages surgical and anæsthetic methods are described and the latter are presented particularly well. The bulk of the book, pages 81 to 354, deals, on a regional basis, with operative surgery. With the exception of obstetrical procedures, all the accepted operations in each of the domestic species are described adequately. Before explaining the technique for each operation the authors give the anatomy of the part, the indications for the interference, the instruments required and the anæsthesia to be used. The technical descriptions are precise and clear. The last fourteen pages are concerned with methods of restraint. This section is unduly brief and familiar.

The authors have succeeded in producing a very practical surgical compendium for both student and practitioner. There is a real need for such an up-to-date book in English. Of necessity, in a book of such reasonable size, much has been omitted but the essentials have been retained and, on the whole, the authors and publishers should be congratulated for a very worthwhile achievement.

XUM

MY DOG, TULIP: LIFE WITH AN ALSATIAN, by J. R. Ackerley. Secker and Warburgh, 7 John Street, London, W.C.1. Price, 10s. 6d. net.

I READ this book whilst on a train going to the West of England. I find it difficult to read for long in the train for there are so many things to attract my attention away from any script. This little book held me prisoner. Although there is no information in it which is not common knowledge to a veterinary surgeon the tale is told with a subtle humour which kept me chuckling. My mirth drew the attention of an elderly lady sitting opposite who, at a favourable opportunity, no doubt with a view to future reading, inquired for the title and theme. I told her the title but I was at a loss to express the theme for although the story is told with a delicate and humorous air, some of the incidents could not, without embarrassment, be the topic of conversation between a modest man and an apparent spinster getting on in years.

Mr. Ackerley must have been an "innocent" when he acquired Tulip. He must have left school long before the biology of the "birds and bees" became an intriguing and commonplace topic amongst adolescents. Anxious to please and understand his bitch he sought advice on her management, feeding and sex affairs from all and sundry. He got plenty, some amusing, some ludricrous and a great deal of it being contradictory that it is not surprising that in his efforts to implement it his whole life was devoted to practising the various tenets necessary for the bitch's' welfare. His search for a suitable mate to satisfy her sex instincts, which he was informed is necessary for health, was all without effect until the dog from next door "popped over the fence." There were eight pups and this in a small flat. He had to take up his carpets, protect the furniture with chicken-wire and he wore himself out attending to the feeding and hygiene of the pack. When the time came to find them homes his heart almost failed and I would not have been surprised if he had kept the lot.

It is a story which has its repetition in thousands of homes when a dog creeps into the hearts of its owners and especially so when the dog is of the female sex. I am sure that veterinary surgeons will gain great delight in reading this story so full of subtle humour and from the other side, the owner's side, of the fence.

NEWS

SIR THOMAS DALLING retired on April 24 from his post as senior veterinarian with the Food and Agriculture Organisation of the United Nations.

He graduated at the Royal Dick Veterinary College in 1914. He served in the A.V.C. in World War I and then devoted himself to research and made outstanding contributions regarding certain diseases of sheep. He was appointed professor of animal pathology at Cambridge University in 1937. In 1942 he joined the Ministry of Agriculture and was chief veterinary officer from 1948 to 1952. He retired to join the Food and Agriculture Organisation of the United Nations.

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Sir Thomas is of the opinion that the work on rinderpest control is the most important achievement during his period with F.A.O. The disease has been stamped out in a number of countries and reduced to comparative insignificance in many others.

He was largely responsible for the inauguration of the European Foot-and-Mouth Commission which, working alongside the International Office of Epizootics, has done much to attain a measure of co-operation and agreement in combating this disease.

In his retirement, Sir Thomas is going to devote himself to the cause of veterinary education especially with regard to the needs of underdeveloped countries.

The Services of Biological Consultants

THE period since the end of the 1939-45 war has seen a rapid growth of biological problems in industry and this has resulted in the appearance of an appreciable number of full-time consultants having considerable experience of technology and industrial research in biology. The Institute of Biology publishes a Directory of Biological Consultants which includes details of the fields covered by independent consultants in biology. The subjects include: bacteriology; fungal spoilage; industrial microbiology; dairy bacteriology; microbiological assay; food hygiene; antiseptics; disinfectants; brewing; applied entomology; industrial and household pests; biological assay of insecticides; nutrition, both human and animal; toxicology; ecology and land use; parasitology; pollution of rivers; sewage disposal; decay of timbers; wild-life conservation. The Institute of Biology can help industrial firms and public bodies needing advice on other, more specialised subjects by finding suitably qualified biologists who are willing to give advice.

THE Committee of Privy Council for Agricultural Research have appointed Professor J. W. Howie, M.D., M.R.C.P., to fill a vacancy in the membership of the Agricultural Research Council caused by the resignation of Professor J. S. Young, M.C., M.A., B.Sc., M.D.

Professor Howie is Gardiner Professor of Bacteriology at Glasgow University and was formerly Head of the Department of Pathology and Bacteriology at the Rowett Research Institute, Aberdeen.

NOTICES

MESSRS. BIOREX (MARKETING) LTD. wish to advise the profession that they have appointed Messrs. J. M. Loveridge Ltd., of 6 Millbrook Road, Southampton, as sole distributors of their Biosone G.A. range of veterinary preparations, containing the active isomers of glycyrrhetinic acid. Supplies can be obtained through the veterinary wholesalers.

XUM

THE Armour Laboratories, Hampden Park, Eastbourne, are pleased to announce the appointment of Messrs. W. Gimber & Sons Ltd., Peckham, London, S.E.15, as sole distributors in the United Kingdom for their range of veterinary medicines including P.O.P. (Purified Oxytocic Principle), Fantomar, Adrenomone (A.C.T.H.), and Tryptar.

Messrs. W. Gimber & Sons Ltd. are also stockists of Armour suture and ligature materials.

MESSRS. ALLEN & HANBURYS LTD. announce the introduction of Pentolissin which is a combined injection of pentobarbitone and mephenesin. It is an improved general anæsthetic for intravenous administration to small animals.

It is claimed that safer and more reliable anæsthesia can be obtained by using Pentolissin. Pre- or post-operative excitement is extremely rare, and the degree of muscle relaxation obtained considerably facilitates surgical procedures.

The price is as follows: Pentolissin: Each c.c. contains pentobarbitone sodium B.Vet.C. 64 mg. and mephenesin B.P.C. 32 mg. Vial of 100 c.c., 13/6. Exempt from purchase tax.

ERRATA

Article by Larin and Wooldridge, May, 1957. Page 191, paragraph two, line nine, "eight" should read "ten." Page 193, last paragraph, line four, "necessary" should read "necessarily." Page 193, last paragraph, line six, "two" should read "four." Page 195, paragraph four, line 18, "1955" should read "1956." Page 196, paragraph six, line two, insert "of dogs" after "inoculation." Page 196, paragraph six, lines eight and nine, substitute "had not made" for "did not make." Page 197, paragraph three, line two, "œtiological" should read "ætiological." Page 197, paragraph four, line ten, "case" should read "cases." Page 197, last paragraph, line five, "seven" should read "nine." Page 199, paragraph two, line eight, "poliomyelitic" should read "poliomyelitis." References: Fenner, F.—"1905" should read "1950." "Larin, N. M., and Orbell, W. G. (1956): In press," should read "Larin, N. M., and Orbell, W. G. (1956): *J. Hyg. Camb., 54,* 141." "Quastel, J. M., and Wooldridge, W. R." should read "Quastel, J. H., and Wooldridge, W. R."

The editors regret the amount of errata necessary with regard to this article and would point out that the prompt return of authors proofs and corrections would eliminate the necessity for such extensive post-publication notices.

CORRIGENDUM

Regarding the article by M. Gitter, M.R.C.V.S., which appeared in the April and May issues of this Journal, the manuscript was received for publication on November 14, 1956.